Claims

1. A fuel cell comprising:

a polymer electrolyte membrane; and

a pair of diffusion electrodes sandwiching the polymer electrolyte membrane;

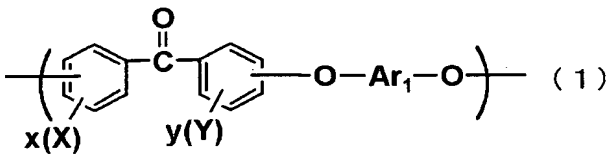
wherein the polymer electrolyte membrane comprising a first resin;

the diffusion electrode comprising a porous base member and a catalyst layer, the catalyst layer being formed so as to be in contact with the porous base member, and the catalyst layer comprising a catalyst and a second resin having a protonic acid group;

an intermediate layer being provided between the polymer electrolyte membrane and at least one of the diffusion electrodes, the intermediate layer comprising a third resin and catalyst particles; and

the third resin comprising a protonic acid group-containing crosslinked polymer having an aromatic unit.

2. The fuel cell according to Claim 1, wherein the third resin includes a repeating structural unit represented by Formula (1) below and a repeating structural unit represented by Formula (2) below:



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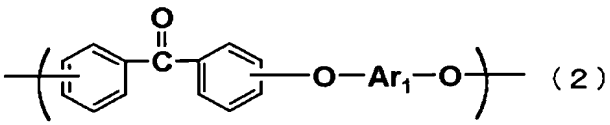
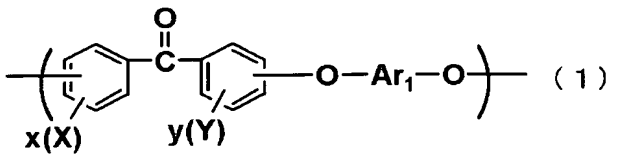


(2)

(in Formulae (1) and (2), each Ar_1 independently represents a divalent group containing an aromatic ring; a straight-chain or branched-chain alkyl group having 1 to 20 carbon atoms is directly bonded to at least one of the aromatic rings; a hydrogen of the aromatic ring may be substituted by an alkyl group, a halogenated hydrocarbon group, or a halogen; X and Y each represents a protonic acid group selected from a sulfonic acid group, a carboxylic acid group, a phosphoric acid group, or a sulfonimide group, or a metal salt thereof; x and y are integers of 0 or higher; and x + y is 1 or higher).

3. The fuel cell according to Claim 1, wherein the first resin is a resin formed by crosslinking a protonic acid group-containing crosslinkable aromatic polyether ketone.

4. The fuel cell according to Claim 1, wherein the first resin includes a repeating structural unit represented by Formula (1) below and a repeating structural unit represented by Formula (2) below:



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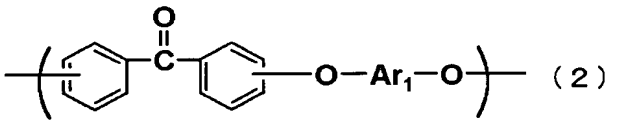


(2)

(in Formulae (1) and (2), each Ar_1 independently represents a divalent group containing an aromatic ring; a straight-chain or branched-chain alkyl group having 1 to 20 carbon atoms is directly bonded to at least one of the aromatic rings; a hydrogen of the aromatic ring may be substituted by an alkyl group, a halogenated hydrocarbon group, or a halogen; X and Y each represents a protonic acid group selected from a sulfonic acid group, a carboxylic acid group, a phosphoric acid group, or a sulfonimide group, or a metal salt thereof; x and y are integers of 0 or higher; and x + y is 1 or higher).

5. The fuel cell according to Claim 1, wherein the intermediate layer further comprises the second resin.

6. The fuel cell according to Claim 1, wherein the second resin comprises a sulfonic acid group-containing perfluorocarbon polymer compound.

7. The fuel cell according to Claim 1, wherein the third resin content of the intermediate layer on a side that is in contact with the polymer electrolyte membrane is higher

than the third resin content of the intermediate layer on a side that is in contact with the diffusion electrode.

8. The fuel cell according to Claim 1, wherein the catalyst particles contained in the intermediate layer comprise conductive particles and a metal catalyst supported on the conductive particles.

9. The fuel cell according to Claim 1, wherein methanol fuel is supplied to one of the diffusion electrodes.

10. A fuel cell comprising:

a polymer electrolyte membrane; and

a pair of diffusion electrodes sandwiching the polymer electrolyte membrane;

wherein the polymer electrolyte membrane comprising a first resin;

the diffusion electrode comprising a porous base member and a catalyst layer, the catalyst layer being formed so as to be in contact with the porous base member, and the catalyst layer comprising a catalyst and a second resin having a protonic acid group;

an intermediate layer being provided between the polymer electrolyte membrane and at least one of the diffusion electrodes, the intermediate layer comprising a third resin and catalyst particles; and

the third resin comprising a protonic acid group-containing aromatic polyether ketone.

11. The fuel cell according to Claim 10, wherein the third resin is a crosslinkable resin.

12. The fuel cell according to Claim 10, wherein the third resin is a crosslinked resin.

13. A fuel cell comprising:

a polymer electrolyte membrane; and

a pair of diffusion electrodes sandwiching the polymer electrolyte membrane;

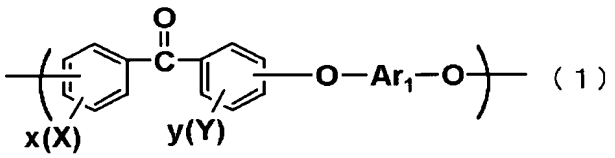
wherein the polymer electrolyte membrane comprising a first resin;

the diffusion electrode comprising a porous base member and a catalyst layer, the catalyst layer being formed so as to be in contact with the porous base member, and the catalyst layer comprising a catalyst and a second resin having a protonic acid group;

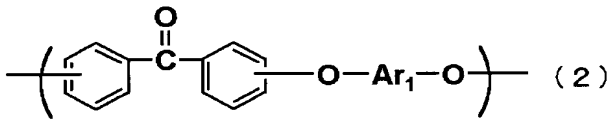
an intermediate layer being provided between the polymer electrolyte membrane and at least one of the diffusion electrodes, the intermediate layer comprising a third resin and catalyst particles; and

the first resin being a resin formed by crosslinking a protonic acid group-containing crosslinkable aromatic polyether ketone.

14. The fuel cell according to Claim 13, wherein the first resin includes a repeating structural unit represented by Formula (1) below and a repeating structural unit represented by Formula (2) below



(1)



(2)

(in Formulae (1) and (2), each Ar_1 independently represents a divalent group containing an aromatic ring; a straight-chain or branched-chain alkyl group having 1 to 20 carbon atoms is directly bonded to at least one of the aromatic rings; a hydrogen of the aromatic ring may be substituted by an alkyl group, a halogenated hydrocarbon group, or a halogen; X and Y each represents a protonic acid group selected from a sulfonic acid group, a carboxylic acid group, a phosphoric acid group, or a sulfonimide group, or a metal salt thereof; x and y are integers of 0 or higher; and x + y is 1 or higher).

15. A method for manufacturing a fuel cell, the method comprising:

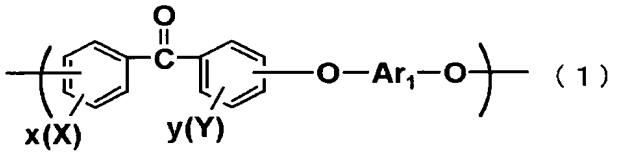
a step of arranging, on opposite surfaces of a polymer electrolyte membrane comprising a first resin, a pair of diffusion electrodes comprising a porous base member and a

catalyst layer, the catalyst layer being formed so as to be in contact with the porous base member, and the catalyst layer comprising a catalyst and a second resin having a protonic acid group and applying pressure or heat in this state so as to unite the diffusion electrodes and the polymer electrolyte membrane,

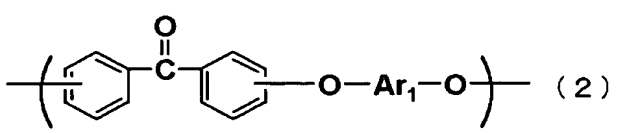
wherein, prior to the above-mentioned step, at least one surface of the polymer electrolyte membrane is coated with a coating solution comprising catalyst particles and a third resin comprising a protonic acid group-containing crosslinkable aromatic polyether ketone.

16. The method for manufacturing a fuel cell according to Claim 15, wherein, after coating with the coating solution, the third resin is crosslinked by heating or by irradiation with electromagnetic waves.

17. The method for manufacturing a fuel cell according to Claim 15, wherein the third resin comprises a repeating structural unit represented by Formula (1) below and a repeating structural unit represented by Formula (2) below



(1)



(2)

(in Formulae (1) and (2), each Ar_1 independently denotes a divalent group containing an aromatic ring; a straight-chain or branched-chain alkyl group having 1 to 20 carbons is directly bonded to at least one of the aromatic rings; a hydrogen of the aromatic ring may be replaced by an alkyl group, a halogenated hydrocarbon group, or a halogen; X and Y each denote a protonic acid group selected from a sulfonic acid group, a carboxylic acid group, a phosphoric acid group, or a sulfonimide group, or a metal salt thereof; x and y are integers of 0 or higher; and x + y is 1 or higher).

18. The method for manufacturing a fuel cell according to Claim 15, wherein the coating solution comprises the second resin.

19. The method for manufacturing a fuel cell according to Claim 15, wherein the second resin comprises a sulfonic acid group-containing perfluorocarbon polymer compound.

20. The method for manufacturing a fuel cell according to Claim 15, wherein the step of applying the coating solution comprises a step of applying a plurality of coating solutions having different contents of the third resin.

21. The method for manufacturing a fuel cell according to Claim 15, wherein the catalyst particles contained in the intermediate layer comprise conductive particles and a metal

catalyst supported on the conductive particles.